Preliminary Investigation on Aquatic Invasive Species of Marine and Estuarine Macrobenthic Invertebrates on Floating Structures in Five British Columbia Harbours

L. Lu, C.D. Levings and G.E. Piercey

Fisheries and Oceans Canada
Science Branch – Pacific Region
DFO-UBC Centre for Aquaculture and Environmental Research
4160 Marine Drive
West Vancouver, B.C.
V7V 1N6

2007

Canadian Manuscript Report of Fisheries and Aquatic Sciences 2814

Fisheries and Oceans / Pêches et Océans

Canada

Canadian Manuscript Report of Fisheries and Aquatic Sciences

Manuscript reports contain scientific and technical information that contributes to existing knowledge but which deals with national or regional problems. Distribution is restricted to institutions or individuals located in particular regions of Canada. However, no restriction is placed on subject matter, and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Manuscript reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1-900 in this series were issued as Manuscript Reports (Biological Series) of the Biological Board of Canada, and subsequent to 1937 when the name of the Board was changed by Act of Parliament, as Manuscript Reports (Biological Series) of the Fisheries Research Board of Canada. Numbers 1426 - 1550 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Manuscript Reports. The current series name was changed with report number 1551.

Manuscript reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport manuscrit canadien des sciences halieutiques et aquatiques

Les rapports manuscrits contiennent des renseignements scientifiques et techniques ques qui constituent une contribution aux connaissances actuelles, mais qui traitent de problèmes nationaux ou régionaux. La distribution en est limitée aux organismes et aux personnes de régions particulières du Canada. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports manuscrits peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports manuscrits sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annual des publications scientifiques et techniques du Ministère.

Les numéros 1 à 900 de cette série ont été publiés à titre de manuscrits (série biologique) de l'Office de biologie du Canada, et après le changement de la désignation de cet organisme par décret du Parlement, en 1937, ont été classés comme manuscrits (série biologique) de l'Office des recherches sur les pêcheries du Canada. Les numéros 901 à 1425 ont été publiés à titre de rapports manuscrits de l'Office des recherches sur les pêcheries du Canada. Les numéros 1426 à 1550 sont parus à titre de rapports manuscrits du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 1551.

Les rapports manuscrits sont produits a l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

2008-00899/

Canadian Manuscript Report of

Fisheries and Aquatic Sciences 2814

2007

PRELIMINARY INVESTIGATION ON AQUATIC INVASIVE SPECIES OF MARINE AND ESTUARINE MACROBENTHIC INVERTEBRATES ON FLOATING STRUCTURES IN FIVE BRITISH COLUMBIA HARBOURS

by

L. Lu, C.D. Levings, and G.E. Piercey

Fisheries and Oceans Canada
Science Branch – Pacific Region
DFO-UBC Centre for Aquaculture and Environmental Research
4160 Marine Drive
West Vancouver, B.C.
V7V 1N6

© Her Majesty the Queen in Right of Canada, 2007
Cat. No. Fs 97-4/2814E ISSN 0706-6473

Correct citation for this publication:

Lu, L., Levings, C.D., and Piercey, G.E. 2007. Preliminary investigation on aquatic invasive species of marine and estuarine macrobenthic invertebrates on floating structures in five British Columbia harbours. Can. Manuscr. Rep. Fish. Aquat. Sci. 2814: iii + 30 p.

ABSTRACT

Lu, L., Levings, C.D., and Piercey, G.E. 2007. Preliminary investigation on aquatic invasive species of marine and estuarine macrobenthic invertebrates on floating structures in five British Columbia harbours. Can. Manuscr. Rep. Fish. Aquat. Sci. 2814: iii + 30 p.

Samples of invertebrate communities on buoys and floating docks at Vancouver, Esquimalt, Nanaimo, Port Alberni and Prince Rupert, British Columbia, were obtained in August and September 2005. The purpose of the preliminary survey was to provide baseline data on the taxonomic composition of the invertebrates, with specific reference to possible aquatic invasive species. Thirty-five invasive or cryptogenic species were found. *Conopeum seurati* (Canu, 1928), a bryozoan native to the Atlantic Ocean, was confirmed from Port Alberni and may be the first record of the species from the northeast Pacific.

RESUME

Lu, L., Levings, C.D., and Piercey, G.E. 2007. Preliminary investigation on aquatic invasive species of marine and estuarine macrobenthic invertebrates on floating structures in five British Columbia harbours. Can. Manuscr. Rep. Fish. Aquat. Sci. 2814: iii + 30 p.

Nous avons prélevé des échantillons des communautés d'invertébrés sur les bouées et les quais flottants à Vancouver, à Esquimalt, à Nanaimo, à Port Alberni et à Prince Rupert (Colombie-Britannique) en août et en septembre 2005. Le but du relevé préliminaire était d'obtenir des données de référence sur la composition taxonomique des invertébrés, en traitant particulièrement des espèces aquatiques envahissantes possibles. Nous avons observé 35 espèces envahissantes ou d'origine indéterminée. Nous avons confirmé la présence de *Conopeum seurati* (Canu, 1928), un bryozoaire indigène de l'océan Atlantique, à Port Alberni, ce qui pourrait constituer la première observation de l'espèce dans le Nord-Est du Pacifique.

INTRODUCTION

Biological invasions are a major global environmental and economic problem. In recent decades, the world has witnessed an array of harmful invasions by exotic marine organisms (Cohen and Carlton 1998; Cohen et al. 2005). Marine and estuarine invasive species are transported into coastal regions mainly through ballast water, ship hulls and introduced aquaculture organisms (Levings et al. 2002). Aquatic invasive species (AIS) of marine origin are most likely found at coastal harbours with past and present ship traffic.

A number of surveys of marine and estuarine invasive species were carried out along the Pacific coast in the United States in the recent decade (Cohen 1998; Cohen et al. 1998; Cohen et al. 2001; Boyd et al. 2002; Cohen et al. 2002; DFG 2002; Fairey et al. 2002; Cohen and Moyle 2004; Cohen et al. 2005). However, few surveys of hard-bottom benthic invertebrates have been undertaken to determine the presence of AIS along the Pacific coast in Canada. Other than the preliminary surveys of Richoux et al. (2006) and Macdonald et al. (2000), no studies have been conducted on macrobenthic invertebrates on floating structures in BC waters. The artificial nature of the surfaces of buoys and floating docks may contribute to the abundance of aquatic invasive organisms, based on the theory that a disturbed or altered environment is more easily invaded (Cohen and Carlton 1998).

The objectives of this study were to develop a preliminary inventory of invertebrate aquatic invasive and cryptogenic species (as defined by Carlton 1996) on buoys and floating docks at harbours in BC, to compare the differences in AIS between regions, and to provide quantitative reference data of benthic communities for future assessments.

MATERIALS AND METHODS

Sample Collection

Five harbours along the BC coast, i.e. Vancouver, Nanaimo (Nanaimo Harbour and Departure Bay), Esquimalt, Prince Rupert and Port Alberni, were selected for this study, and a total of 25 floats or buoys were sampled between 18 Aug 2005 and 20 Sept 2005 (Figure 1). The number of structures sampled in each harbour ranged from three in Port Alberni to eight in Prince Rupert. Sample locations were recorded with a Garmin GPS Model 76. A description of the sampling sites is given in Table 1, and a description of biotic communities in Table 2.

The floating structures were constructed from wood, concrete, and steel. Most had been in the water for at least one year so the communities were of varying age, probably up to at least 10 y in some instances such as the concrete docks in the Navy facilities at Esquimalt. Navigational buoys maintained by the Canadian Coast Guard in BC are hauled out of the water on a three year rotational schedule in British Columbia so the

buoys that were sampled had been in the water for no more than three years. Some of the wood structures were creosoted.

Three quantitative replicate samples were taken from each structure from the water surface downwards using a 0.1m x 0.1m quadrat and a hand scraper. A net with 0.5 mm mesh was used for collecting scraped organisms. The samples were put in plastic jars and fixed in a 10% buffered formalin seawater solution in situ. In the laboratory the benthic samples were washed through a 0.5 mm mesh sieve. Animals retained on the sieve were sorted using a Wild M5 binocular dissecting microscope, identified to the lowest possible taxonomic levels and enumerated. After enumeration samples were stored in 70% isopropyl alcohol. Mussels (*Mytilus* sp.) at Sites 1 and 2 in Vancouver harbour were not counted because they were very abundant at these sites.

Identification of Specimens

All specimens were identified by Lin Lu, except for tanaids, isopods, amphipods and decapods from several samples, which were identified by Phil Hoover, Biologica Environmental Services Ltd., and tunicates which were identified by Debbie Paltzat, Pacific Biological Station, Nanaimo, BC.

Statistical Analysis

Combined data from three replicates at each site were used in all analyses. Non-metric multi-dimensional scaling (MDS), based on similarity using Bray-Curtis coefficient on √√-transformed abundance data, was employed to analyse differences in community structure of benthic invertebrates among sampling sites (Clarke and Warwick 2001). For all colonial species, a value of 10 was input as their abundance. For *Mytilus* sp. mussels at Sites 1 and 2 in Vancouver harbour, an estimate of 2000 was used as its abundance for each replicate sample.

RESULTS

A total of 174 taxa, consisting primarily of polychaetes (50 taxa), amphipods (30 taxa), isopods (11 taxa), gastropods (11 taxa), decapods (nine taxa), bryozoans and tunicates (eight taxa), and cirripeds (seven taxa), were recorded in the survey (Appendix). The results should be considered preliminary, however, as some taxonomic groups may require further identification. All samples have been archived at CAER for possible further identification. For instance, platyhelminths and insect larvae were not identified to the genus level., In addition, *Mytilus* species may include *M. trossulus*, *M. galloprovincialis* and *M. edulis*, or hybrids thereof, which are not readily distinguished morphologically (see Richoux et al. 2006).

The sponge *Halichondria bowerbanki*, the tanaid *Anatanais pseudonormani*, the isopod *Janiralata occidentalis*, the bryozoans *Schizoporella unicornis* and *Schizoporella pseudoerrata*, and all colonial tunicates were only found in Esquimalt. The hydrozoan

Cordylophora caspia, the oligochaetes *Nais elinguis* and Enchytraeidae species, the bivalve *Modiolus* sp., the barnacle *Balanus improvisus*, and the bryozoan *Conopeum seurati* were only recorded in the brackish water of Port Alberni. The amphipod *Ampithoe dalli* was only found in Prince Rupert. The tanaid *Zeuxo normani* was recorded in large numbers in Port Alberni, but it was also found in Vancouver and Nanaimo. There are no obvious patterns in species composition between substrates or among sites, except for the three sites in Port Alberni, formed a distinct group in the MDS plots (Figure 2). The community structure in Port Alberni was significantly different from other sites possibly because the taxa there were adapted to brackish water as the sample area was in the Somass River estuary.

A total of 23 aquatic invasive species and 13 cryptogenic species were recorded during this survey (Table 3). Most of them derived from the North Atlantic or the West Pacific. Three aquatic invasive species (*Cordylophora caspia, Balanus improvisus* and *Conopeum seurati*) were only found in Port Alberni, in large numbers. Three cryptogenic species, *Boccardia columbiana* and *Jassa slatteryi* in Nanaimo and *Zeuxo normani* in Port Alberni, were found in large numbers, but only a few or none were found in other locations. These results suggest that invasive species may establish their populations in certain environments which are suitable for their growth.

The highest total number of species (98) was found in Prince Rupert and the highest mean number (55) of species per quadrat was found in Esquimalt, while the lowest total number and mean number (15 and 11 species, respectively) were found in the brackish water of Port Alberni (Figure 3). However, the proportions of AIS and AIS or cryptogenic species combined were highest in Port Alberni (Figure 4).

DISCUSSION

There were different designations of status for some species in previous reports of AIS from the northeast Pacific.. The polychaetes *Capitella capitata* and *Harmothoe imbricate* have been reported as cryptogenic species in this region (Cohen and Carlton 1995; Golden et al. 1998; DFG 2002; Fairey et al. 2002; T N and Associates 2002). Boyd et al. (2002) reported the amphipod *Jassa slatteryi* as a non-indigenous species from the Eastern Pacific, but DFG (2002) and Fairey et al. (2002) considered it a native species. *Ianiropsis tridens* was reported as an exotic species by some reports (Cohen et al. 1998; Cohen et al. 2002; DFG 2002; Cohen et al. 2005), but Fairey et al. (2002) considered it a native species.

The bryozoan *Conopeum seurati* typically occurs in estuarine and brackish habitats of Northern Europe and the Mediterranean. It shows large tolerance to salinity and temperature variations, including freezing and drying out, and has been collected in estuaries where salinity is less than 1 psu. Prior to Winston's (1982) study, this species had not been reported in the western hemisphere. *C. seurati* was found in the brackish habitat of Port Alberni in this survey and may have been introduced from the east coast of

the United States. This may be the first record of this species on the Pacific coast of North America.

The theory that species-poor communities are more vulnerable to invasion than are other communities and species-rich communities could resist invasions (Cohen and Carlton 1998) is relevant to this survey. There were only 15 species found in Port Alberni, fewer than found in the other four harbours (56-98 species), possibly due to the harsh conditions of a brackish environment. However, the relative number of invasive/cryptogenic species (26.7% and 33.3%, respectively) was higher in the brackish water of Port Alberni harbour during this survey. Our results are consistent with the above-cited theory and suggest that estuarine/brackish environments may be more easily invaded by exotic species.

Due to sampling limitations, we were able to only collect quantitative samples from the water surface downwards to a depth of 0.1m. The sampling method excluded intertidal species and those living deeper than 0.1 m. We suggest that more surveys on aquatic invasive species should be carried out at more sites on the coast of BC. When navigation buoys are lifted for cleaning, the organisms on the bottoms of the structures would be easily accessible. On the Atlantic coast, where numerous buoys are lifted every year by the Canadian Coast Guard because of ice conditions, such sampling has been considered as a monitoring method for AIS (McKindsey and Landry 2006). However on the Pacific coast, because the buoys are lifted every three years on a rotating cycle in various harbours, an annual monitoring survey would not be possible. As well, harbours on the Pacific coast seem to have fewer navigational buoys. For example Vancouver has only 14 lighted floating navigational buoys maintained by the Canadian Coast Guard, of which 13 are either at Roberts Bank, or off Point Grey, outside Burrard Inlet.

ACKNOWLEDGEMENTS

We would like to thank Piotr Kuklinski and Paul D. Taylor at Department of Palaeontology, Natural History Museum in London, UK, who confirmed the identification of the bryozoan *Conopeum seurati*. Sheila Byers, Integrated Resource Consultants, Richmond, B.C assisted with identification of certain polychaetes. Thanks are also owing to the various harbourmasters who cooperated with the sampling. Holly Smith in DFO Prince Rupert office assisted with sampling at that location and also kindly arranged for a Conservation and Protection vessel. Dr. Terry Foster, Defence Research and Development Canada, Victoria, facilitated sampling at the Esquimalt naval docks. Funding was provided by DFO Biodiversity Science Branch, NCR and Pacific Science Branch. Herb Herunter provided editorial comments.

REFERENCES

Boyd, M.J., Mulligan, T.J. and Shaughnessy, F.J. 2002. Non-Indigenous Marine Species of Humboldt Bay, California. Department of Fish and Game, California, 118 pp. Available online at http://www.humboldtbay.org/conservation/exoticspecies/non_indigenous_marine_boyd_etal_2002.pdf.

Carlton, J.T. 1996. Biological invasions and cryptogenic species. Ecology 77(6): 1653-1655.

Clarke, K.R. and Warwick, R.M. 2001. Change in marine communities: an approach to statistical analysis and interpretation. 2nd Edition. Plymouth, UK, 177 pp.

Cohen, A.N. 1998. Ships' Ballast Water and the Introduction of Exotic Organisms into the San Francisco Estuary: Current Status of the Problem and Options for Management. California Urban Water Agencies, 90 pp. Available online at http://www.sfei.org/bioinvasions/Reports/1998-BallastWater224.pdf.

Cohen, A.N. and Carlton, J.T. 1995. Non-indigenous Aquatic Species in a United States Estuary: A Case Study of the Biological Invasions of the San Francisco Bay and Delta. U.S. Fish and Wildlife Service, Washington, DC. Available online at http://nsgl.gso.uri.edu/conn/connt95002/connt95002full.pdf.

Cohen, A.N. and Carlton, J.T. 1998. Accelerating invasion rate in a highly invaded estuary. Science 279: 555-558.

Cohen, A.N. and Moyle, P.B. 2004. Summary of Data and Analyses Indicating That Exotic Species Have Impaired the Beneficial Uses of Certain California Waters. State Water Resources Control Board, 25 pp. Available online at http://www.sfei.org/bioinvasions/Reports/2004-ImpairedCalWaters382.pdf.

Cohen, A.N., Berry, H., Mills, C.E., Milne, D., Britton-Simmons, K., Wonham, M.J., Second, D, Barkas, J.A., Bingham, B., Bookheim, B., Byers, J., Chapman, J.W., Cordell, J.R., Dumbauld, B., Fukuyama, A., Harris, L.H., Kohn, A., Li, K., Mumford, T., Radashevsky, V., Sewell, A. and Welch, K. 2001. Washington State Exotics Expedition 2000: A Rapid Survey of Exotic Species in the Shallow Waters of Elliott Bay, Totten and Eld Inlets, and Willapa Bay. The Nearshore Habitat Program, Washington State Department of Natural Resources, Olympia, WA, 52 pp. Available online at http://www.sfei.org/bioinvasions/Reports/2001-2000WashingtonSrvy355.pdf.

Cohen, A.N., Harris, L.H., Bingham, B.L., Carlton, J.T., Chapman, J.W., Lambert, C.C., Lambert, G., Ljubenkov, J.C., Murray, S.N., Rao, L.C., Reardon, K. and Schwindt, E. 2002. Project Report for the Southern California Exotics Expedition 2000: A Rapid Assessment Survey of Exotic Species in Sheltered Coastal Waters. California Department of Fish and Game, Sacramento CA; State Water Resources Control Board, Sacramento CA; National Fish and Wildlife Foundation, San Francisco, 31 pp. Available online at http://www.sfei.org/bioinvasions/Reports/2002-2000SoCalifsurvey_384.pdf.

Cohen, A.N., Harris, L.H., Bingham, B.L., Carlton, J.T., Chapman, J.W., Lambert, C.C., Lambert, G., Ljubenkov, J.C., Murray, S.N., Rao, L.C., Reardon, K. and Schwindt, E. 2005. Rapid assessment survey for exotic organisms in southern California bays and harbors, and abundance in port and non-port areas. Biological Invasions 7(6): 995-1002.

Cohen, A.N., Mills, C.E., Berry, H., Wonham, M.J., Bingham, B., Bookheim, B., Carlton, J.T., Chapman, J.W., Cordell, J.R., Harris, L.H., Klinger, T., Kohn, A., Lambert, C.C., Lambert, G., Li, K., Second, D. and Toft, J. 1998. Report of the Puget Sound Expedition, September 8-16, 1998: A Rapid Assessment Survey of Non-indigenous Species in the Shallow Waters of Puget Sound. The Nearshore Habitat Program, Washington State Department of Natural Resources, Olympia, WA, 41 pp. Available online at http://www.sfei.org/bioinvasions/Reports/1998-1998PugetSound378.pdf.

DFG. 2002. A Survey of Non-Indigenous Aquatic species in the Coastal and Estuarine Water of California. Department of Fish and Game, California. Submitted to the California State Legislature as Required by the Ballast Water Management Act of 1999, 37 pp. + appendices. Available online at http://www.dfg.ca.gov/ospr/organizational/scientific/exotic/exotic%20report.htm.

Fairey, R., Dunn, R., Roberts, C., Sigala, M. and Oliver, J. 2002. Introduced Aquatic Species in California Coastal Waters – Final Report. Department of Fish and Game, California, 116 pp. Available online at http://www.dfg.ca.gov/ospr/organizational/scientific/exotic/Appendix%20A%20-%20Moss%20Landing%20Report%20Bookmarked.pdf.

Golden, J.T., Gillingham, D.M., Krutzikowsky, V.H., Fox, D., Johnson, J.A., Sardina, R. and Hammond, S. 1998. A Biological Inventory of Benthic Invertebrates in Tillamook Bay. Oregon Department of Fish and Wildlife, Newport, OR. Cited in Cohen, A.N. 2004. An Exotic Species Detection program for Tillamook Bay. Prepared for the Tillamook Estuaries Partnerhip. Garibaldi, OR. Available online at http://www.sfei.org/bioinvasions/Reports/2004-TillamookBayESDP379.pdf.

Levings, C.D., Kieser, D., Jamieson, G.S. and Dudas, S. 2002. Marine and estuarine alien species in the Strait of Georgia, British Columbia. Pp. 111-131. In: R. Claudia, P. Nantel, and E. Muckle-Jeffs (Eds). Alien Invaders in Canada's Waters, Wetlands, and Forests. Natural Resources Canada, Canadian Forest Service, Ottawa. 320 pp.

Macdonald, V.I., Byers, S.C., Budenski, B. and Hoover, P. 2000. Reconnaissance Study to Determine Presence of Marine Exotic Species in the Georgia Strait Basin. Prepared for DFO Science Branch, West Vancouver Laboratory by Biologica Environmental Services, Victoria, BC 41 pp. Available from Centre for Aquaculture and Environmental Research (formerly West Vancouver Laboratory).

McKindsey, C. and Landry, T. 2006. Review of AIS situation in PEI and AIS monitoring in Eastern Canada. Presented at the Workshop Priorities for Monitoring Aquatic Invasive Species in Pacific Region held 23-24 May 2006, at the Institute of Ocean Sciences, Sidney, B.C. Convened by Perry, T. and Levings, C.D. (Power Point presentation available from the authors at Fisheries and Oceans, Institut Maurice-Lamontagne, Mont-Joli, QC).

Richoux, N.B., Levings, C.D., Lu, L. and Piercey, G.E. 2006. Survey of indigenous, non-indigenous and cryptogenic benthic invertebrates in Burrard Inlet, Vancouver, British Columbia. Canadian Data Report of Fisheries and Aquatic Sciences 1183: 20 pp.

T N & Associates. 2002. Compiling Lists of Non-indigenous Species (from the West Coast of the United States, Excluding San Francisco Bay). National Center for Environmental Assessment, U.S. Environmental Protection Agency, Washington, D.C. Cited in Cohen, A.N. 2004. An Exotic Species Detection Program for Tillamook Bay. Prepared for the Tillamook Estuaries Partnership. Garibaldi, OR. Available online at http://www.sfei.org/bioinvasions/Reports/2004-TillamookBay ESDP379.pdf

Winston, J.E. 1982. Marine bryozoan (Ectoprocta) of the Indian River Area (Florida). Bulletin American Museum Natural History 173: 99-176.

Table 1. Descriptions of sampling sites. * position estimated from hydrographic chart

Site No.	Site Location	Latitude	Longitude	Sampling Date (dd/mm/yy)	Substrate
1	Buoy Q41, Vancouver	49°17'6.9''N	123°08'55.5''W	18/08/05	Metal
2	Buoy Q52, Vancouver	49°16'53.4''N	123°08'58.3''W	18/08/05	Metal
3	Buoy QC, Vancouver	49°18'12.2''N	123°09'59.9''W	18/08/05	Metal
4	Buoy Q65, Vancouver	49°18'40.8''N	123°07'37.8''W	18/08/05	Metal
5	CAER dock, West Vancouver	49°20'24.4''N	123°13'59.0''W	18/08/05	Concrete
6	Floatplane dock, Nanaimo	49°10'14.3''N	123°56'1.0''W	25/08/05	Concrete
7	Lighthouse Restuarant dock, Nanaimo	49°10'7.6''N	123°56'7.2''W	25/08/05	Concrete
8	Buoy P9, Nanaimo	49°10'24.3''N	123°56'7.0''W	25/08/05	Metal
9	Buoy P11, Nanaimo	49°10'33.8''N	123°56'14.3''W	25/08/05	Metal
10	Buoy P12, Nanaimo	49°10'35.0''N	123°56'10.0''W	25/08/05	Metal
11	PBS dock, Nanaimo	49°12'37.0''N	123°57'22.4''W	25/08/05	Concrete
12	B Jetty, Esquimalt *	48°25'57''N	123°25'57''W	09/09/05	Wood
13	C Jetty Camber, Esquimalt *	48°25'56''N	123°25'55''W	09/09/05	Concrete
14	C Jetty Westside, Esquimalt *	48°25'58''N	123°25'55''W	09/09/05	Wood
15	DFO dock, Seal Cove, Prince Rupert	54°19'51.6''N	130°16'45.3''W	12/09/05	Wood
16	Float, Cow Bay, Prince Rupert	54°19'6.9''N	130°19'16.1''W	12/09/05	Concrete
17	Barge Mooring Buoy, Prince Rupert	54°19'23.7''N	130°20'39.7''W	12/09/05	Metal
18	Digby Island dock, Prince Rupert	54°18'47.0''N	130°24'13.1''W	12/09/05	Concrete
19	Fairview Terminal, Prince Rupert	54°17'19.9''N	130°21'35.7''W	12/09/05	Metal
20	Buoy D43, Prince Rupert	54°13'14.9''N	130°21'43.0''W	12/09/05	Metal
21	Floating dock, Port Edward	54°14'44.2''N	130°17'52.3''W	12/09/05	Wood
22	Mooring Buoy, Porpoise Harbour, Prince Rupert	54°14'1.9''N	130°18'2.7''W	12/09/05	Metal
23	Government dock, Port Alberni	49°14'12.4''N	124°48'56.0''W	20/09/05	Concrete
24	Government dock inside, Port Alberni	49°14'12.8''N	124°48'45.2''W	20/09/05	Concrete
25	Harbour Quay Marina, Port Alberni	49°13'55.4''N	124°48'50.5''W	20/09/05	Concrete

Table 2. Characterization of the benthic communities at sampling sites

Site No.	Description of Biotic Community
1	A relative diverse community highly dominated by mussels, with amphipods, polychaetes, barnacles and insects
2	A relative diverse community highly dominated by mussels, with amphipods, polychaetes, barnacles and insects
3	< 5% biotic coverage, green algae, barnacle
4	A relative diverse community highly dominated by mussels, with barnacles, polychaetes and insects
5	A relative diverse community highly dominated by mussels, with barnacles, isopods, polychaetes, insects and amphipods
6	A diverse community highly dominated by mussels, with high abundances of amphipods, polychaetes and barnacles
7	A diverse community dominated by amphipods, with green and brown algae, polychaetes, small barnacles and mussels
8	20% biotic coverage, dominated by amphipods, with green algae, polychaetes, mussels, barnacles and hydrozoans
9	10% biotic coverage, dominated by amphipods, with green algae, small numbers of mussels and barnacles
10	10% biotic coverage, amphipods, mussels, decapods and hydrozoans
11	A diverse community dominated by mussels and polychaetes
12	A diverse community dominated by amphipods, with ascidians and high abundance of tanaids, large barnacles and polychaetes
13	A diverse community with sponge, ascidians and high abundances of amphipods, polychaetes, isopods and barnacles
14	A diverse community with sponge, ascidians and high abundances of tanaids, amphipods, polychaetes and isopods
15	A relative simple community with tube polychaetes and barnacles
16	A relative simple community with barnacles, tube polychaetes, limpets, bivalves, and amphipods
17	20% biotic coverage, green algae, insects, barnacles, and other invertebrates
18	A diverse community dominated by amphipods, with high abundance of isopods and polychaetes, and a number of gastropods, bivalves, barnacles, sea spiders and insects
19	A relative diverse community dominated by barnacles, with a number of amphipods, polychaetes and limpets
20	A relative simple community dominated by amphipods, with high abundances of barnacles and insects
21	A sparse community with green algae, barnacles, polychaetes, and other invertebrates
22	A relative simple community dominated by barnacles, with green algae and high abundance of amphipods and insects
23	A brackish community dominated by barnacles and tanaids, with oligochaetes, amphipods, insects, hydrozoans and bryozoans
24	A brackish community dominated by tanaids and oligochaetes, with barnacles, amphipods, insects, hydrozoans and bryozoans
25	A brackish community dominated by tanaids and oligochaetes, with barnacles, amphipods, insects, hydrozoans and bryozoans

Table 3. Aquatic invasive and cryptogenic (*) species found in this survey

Species	Recorded Harbour	Source
Cnidaria: Hydrozoa		
Cordylophora caspia (Pallas, 1771)	Port Alberni	Black/Caspian Seas
Obelia cf. dichotoma (Linnaeus, 1758)*	Nanaimo, Prince Rupert, Vancouver, Esquimalt	N Atlantic
Sarsia tubulosa (Sars, 1835)	Prince Rupert, Esquimalt	N Atlantic
Annelida: Polychaeta		
Amblyosyllis cf. speciosa Izuka, 1912	Esquimalt	NW Pacific
Amphiglena cf. mediterranea (Leydig, 1851)	Esquimalt	N Atlantic
Boccardia columbiana Berkeley, 1927*	Nanaimo, Prince Rupert, Esquimalt	NW Pacific
Capitella capitata (Fabricius, 1780)*	Prince Rupert, Vancouver	N Atlantic or E Pacific
Eteone longa (Fabricius, 1780)*	Nanaimo	N Atlantic
Eusyllis blomstrandi Malmgren, 1867	Prince Rupert	N Atlantic
Eusyllis japonica Imajima and Hartman, 1964	Prince Rupert	NW Pacific
Harmothoe imbricate (Linnaeus, 1767)*	Nanaimo, Prince Rupert, Vancouver, Esquimalt	N Atlantic
Nereis pelagica Linnaeus, 1758	Nanaimo, Prince Rupert, Vancouver, Esquimalt	N Atlantic
Perinereis sp.	Vancouver	Unknown
Pholoe minuta (Fabricius, 1780)	Nanaimo, Vancouver	N Atlantic
Platynereis bicanaliculata (Baird, 1863)*	Nanaimo, Prince Rupert, Vancouver, Esquimalt	NW Pacific
Polydora cornuta Bosc, 1802	Vancouver	N Atlantic
Polydora limicola Annenkova, 1934	Prince Rupert, Esquimalt	NW Pacific, Bering Sea
Polydora websteri Hartman, 1943	Esquimalt	N Atlantic
Proceraea cornuta (Agassiz, 1862)*	Nanaimo, Prince Rupert, Vancouver, Esquimalt	NW Atlantic
Serpula vermicularis Linnaeus, 1767	Prince Rupert	N Atlantic
Typosyllis alternata (Moore, 1908)*	Prince Rupert, Vancouver, Esquimalt	NW Pacific
Typosyllis armillaris (Müller, 1776)	Prince Rupert	N Atlantic
Typosyllis cf. pulchra (Berkeley and Berkeley, 1938)*	Nanaimo, Prince Rupert, Vancouver, Esquimalt	NW Pacific, Bering Sea
Arthropoda: Cirripedia		
Balanus improvisus Darwin, 1854	Port Alberni	N Atlantic
Arthropoda: Tanaidacea		
Leptochelia dubia (Krøyer, 1842)*	Nanaimo	N Atlantic
Zeuxo normani (Richardson, 1905)*	Nanaimo, Vancouver, Port Alberni	Unknown
Arthropoda: Isopoda		
Ianiropsis tridens Menzies, 1952	Prince Rupert	NW Pacific

Table 3 (continued)

Species	Recorded Harbour	Source
Arthropoda: Amphipoda		
Ampithoe valida Smith, 1873	Nanaimo, Prince Rupert, Vancouver, Esquimalt	NW Atlantic
Caprella drepanochir Mayer, 1890*	Prince Rupert	Unknown
Ischyrocerus anguipes Krøyer, 1838	Prince Rupert	N Atlantic
Jassa marmorata Holmes, 1903	Port Alberni	NW Atlantic
Jassa slatteryi Conlan, 1990*	Nanaimo	E Pacific?
Bryozoa		
Bowerbankia gracilis Leidy, 1855	Prince Rupert, Esquimalt	NW Atlantic
Conopeum seurati (Canu, 1928)	Port Alberni	N Atlantic
Schizoporella unicornis (Johnsten, 1874)	Esquimalt	NW Pacific
Tunicata: Ascidiacea		
Botrylloides violaceus Oka, 1927	Esquimalt	NW Pacific

* Cryptogenic species

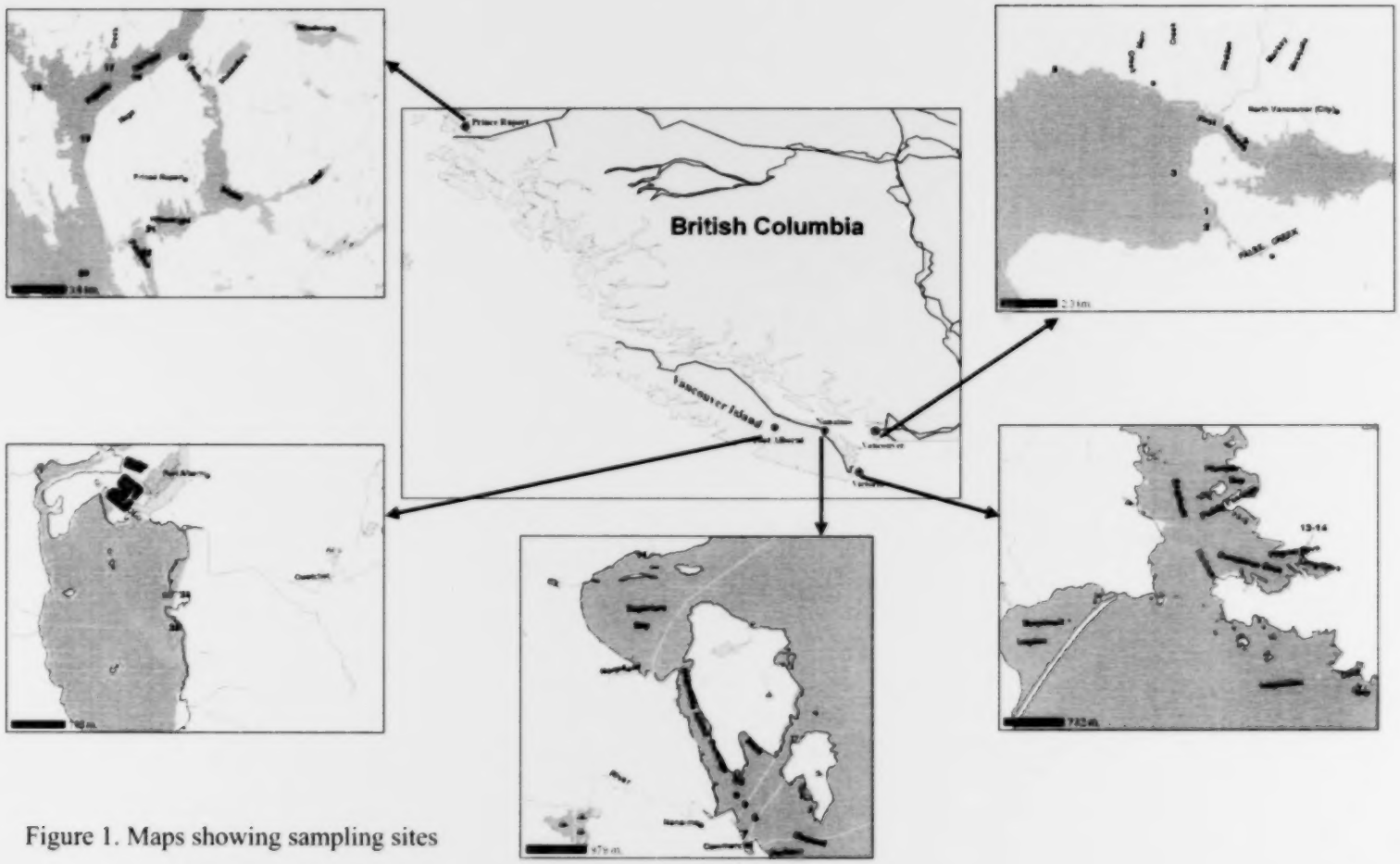

Figure 1. Maps showing sampling sites

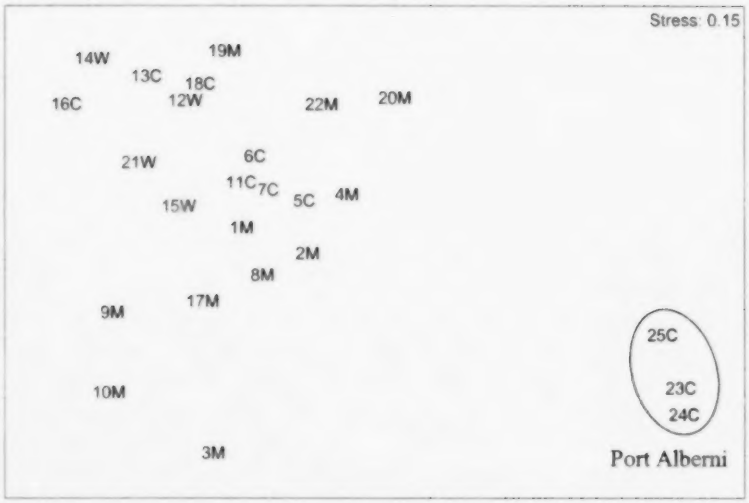

Figure 2. MDS ordination of macrobenthic invertebrates (using Bray-Curtis similarities on √√-transformed abundance) for the 25 sampling sites in this survey. Numbers denote sampling sites (1-5: Vancouver; 6-11: Nanaimo; 12-14: Esquimalt; 15-22: Prince Rupert; 23-25: Port Alberni). Letters stand for substrates (M: metal; C: concrete; W: wood)

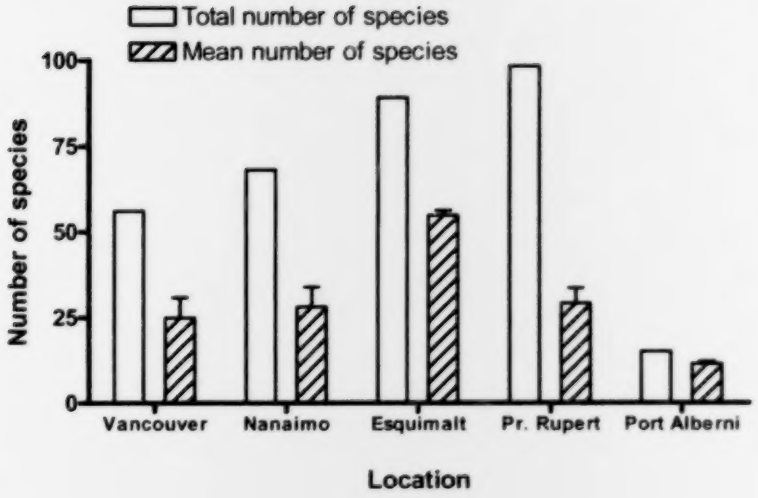

Figure 3. Total number over all structures and mean number of species per structure recorded on buoys and floating docks in the five harbours during this survey

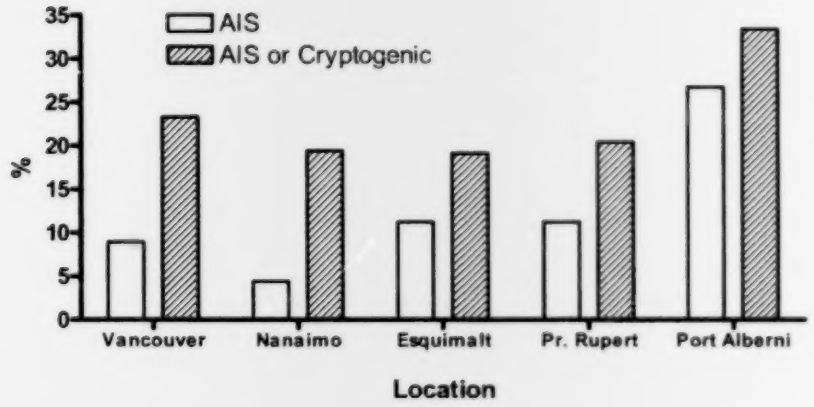

Figure 4. Proportion of AIS and AIS or cryptogenic species combined of benthic invertebrates recorded on buoys and floating docks in the five harbours of BC

Appendix. List of taxa and their abundance (no. 0.01 m^{-2}) recorded at the 25 sites in this survey
"x" = present (if colonial) or in very large numbers

Taxon	Vancouver					Nanaimo						Esquimalt		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Porifera														
Halichondria bowerbanki Burton, 1930													x	x
Cnidaria														
Coral														x
Actinia					1						1		3	6
Cnidaria: Hydrozoa														
Bougainvillia sp.													x	x
Clava sp.														x
Cordylophora caspia (Pallas, 1771)														
Eutonina sp													x	
Garveia annulata Nutting, 1901														x
Obelia cf. dichotoma (Linnaeus, 1758)	x	x	x	x	x	x		x	x	x		x	x	x
Sarsia tubulosa (Sars, 1835)														x
Platyhelminthes														
Platyhelminth		1		2	22	7		9			8			
Nemertea														
Amphiporus sp.	25	15		2	12	9	2				2	4		
Emplectonema gracile (Johnston, 1837)	1	1		55			1					2	1	1
Paranemertes peregrina Coe, 1901					1	1	1				1			
Sipunculida														
Phascolosoma agassizii Keferstein 1866														
Annelida: Polychaeta														
Amblyosyllis cf. speciosa Izuka, 1912													1	7
Amphiglena cf. mediterranea (Leydig, 1851)														8
Armandia brevis (Moore, 1906)				2		2					1			
Arcteobia sp.							1	1						1
Autolytus cf. magnus Berkeley, 1923												6	28	9
Boccadia columbiana Berkeley, 1927					2	164	13				514	5	9	12

Appendix (continued)

Taxon	Vancouver					Nanaimo						Esquimalt		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Brania brevipharyngea Banse, 1972												2	11	35
Capitella capitata (Fabricius, 1780)		1												
Chone minuta Hartman, 1944												4	4	10
Clavadoce sp.													1	
Crucigera zygophora (Johnson, 1901)														
Eteone longa (Fabricius, 1780)											1			
Eudistylia vancouveri (Kinberg, 1867)													2	
Eulalia aviculiseta Hartman, 1936	19	25		7	19	14	3				16			
Eusyllis blomstrandi Malmgren, 1867														
Eusyllis japonica Imajima and Hartman, 1964														
Exogone (Exogone) dwisula Kudenov and Harris, 1905												15	67	127
Halosydna brevisetosa Kinberg, 1855						1					2			
Harmothoe imbricata (Linnaeus, 1767)	3				8	13					4	2	2	
Maldanidae													1	
Micropodarke dubia (Hessie, 1925)						2								
*Minuspio cirrifera (*Wiren, 1883)					1									
Nereis vexillosa Grube, 1851	13	8		59	12	4	7				3	7	7	
Nereis pelagica Linnaeus, 1758	7	2					3					2		
Nereis cf. zonata Malmgren, 1867		4		7	5	3					2		2	
Paleanotus bellis (Johnson, 1897)				2		12	9	4			2	1		
Paradexiospira cf. vitrea (Fabricius, 1780)							4						4	1
Perinereis sp.	1	5												
Pholoe minuta (Fabricius, 1780)	2					1					2			
Pionosyllis sp.														
Platynereis bicanaliculata (Baird, 1863)				8		124	139	21	1		10	11	16	1
Podarke pugettensis Johnson, 1901						1							8	
Polydora cornuta Bosc, 1802				2	1									
Polydora limicola Annenkova, 1934												1	15	4
Polydora pigidialis Blake and Woodwick, 1972						1								

Appendix (continued)

Taxon	Vancouver					Nanaimo						Esquimalt		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Polydora websteri Hartman, 1943							2						2	1
Proceraea cornuta (Agassiz, 1862)	1				4	2		4			3	9	19	18
Questidae sp.														
Sabellidae sp.														
Schizobranchia insignis Bush, 1904													2	5
Serpula vermicularis Linnaeus, 1767														
Sphaerosyllis californiensis Hartman, 1966														
Spionidae sp.														
Spirorbella sp.														
Thelepus sp.													1	
Typosyllis adamanteus (Treadwell, 1914)	38	52		213	52	15	15	3			6			
Typosyllis alternata (Moore, 1908)	2											44	4	39
Typosyllis armillaris (Müller, 1776)														
Typosyllis cf. pulchra (Berkeley and Berkeley, 1938)	27	5		4	10	5						6	6	
Typosyllis cf. hyalina (Grube, 1863)	7				5	152	8				37	11	1	
Annelida: Oligochaeta														
Enchytraeidae sp.														
Nais elinguis Müller, 1773														
Tubificoides sp.		5			3									
Mollusca: Polyplacophora														
Katharina tunicata (Wood, 1815)														
Mopalia sp.1														
Mopalia sp.2														
Mopalia ciliata (Sowerby II, 1840)													1	
Mopalia cirrata Berry, 1919							1							
Mollusca: Gastropoda														
Dentronotus sp.														
Doto columbiana O'Donoghue, 1921														1

Appendix (continued)

Taxon	Vancouver					Nanaimo						Esquimalt		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Doto sp.						2								
Flabellina sp.													1	
Gastropod sp.1					2		1				8			
Haminoea cf. vesicula (Gould, 1855)						2	9				1			
Lacuna sp.						1	2				2	1		1
Lottia spp.	1				9	32	9				22	9		
Littorina sp.							1							
Nudibranch spp.								1						
Polinices sp.														
Mollusca: Bivalvia														
Entodesma sp.														
Lyonsia sp.														
Modiolus sp.														
Mytilus trossulus complex Gould, 1850	x	x	15	15207	9386	3562	129	2	6	11	497	1	2	4
Arthropoda: Crustacea: Ostracoda														
Cypridinidae spp.	3	6			1									
Arthropoda: Crustacea: Cirripedia														
Balanus crenatus Bruguiere, 1789	7	3	5		10	34		5						
Balanus glandula Darwin, 1854	6	39	2	388	197	124	21				1	37	14	5
Balanus improvisus Darwin, 1854													12	7
Balanus nubilus Darwin, 1854				2	1									
Chthamalus dalli Pilsbry, 1916						130	182		1		32		5	
Semibalanus cariosus (Pallas, 1788)												76		1
Solidobalanus hesperius (Pilsbry, 1916)									1	1			29	14
Arthropoda: Crustacea: Tanaidacea														
Anatanais pseudonormani Sieg and Winn, 1981												343	9	540
Leptochelia dubia (Krøyer, 1842)											2			
Zeuxo normani (Richardson, 1905)		1			1	1	32	2			1			

Appendix (continued)

Taxon	Vancouver					Nanaimo						Esquimalt		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Arthropoda: Crustacea: Cumacea														
Leuconidae spp.	1	3									1			
Arthropoda: Crustacea: Isopoda														
Asellota indet. (head only)				1										
Elthusa californica (Schioedte and Meinert, 1884)					1									
Epicaridea indet.						1								
Gnorimosphaeroma oregonensis (Dana, 1853)	1	14		2	160	14		7				11	1	
Ianiropsis analoga Menzies, 1952														
Ianiropsis tridens Menzies, 1952														
Idotea schmittii Menzies, 1950												1		
Idotea wosnesenskii (Brandt, 1851)					65	1					1	1		
Idotea sp.							1							
Limnoria sp.														
Janiralata occidentalis (Walker, 1898)												21	105	24
Munna stephenseni Gurjanova, 1933												24	29	130
Arthropoda: Crustacea: Amphipoda														
Americorophium brevis (Shoemaker, 1949)														
Americorophium spinicorne (Stimpson, 1857)					1									
Ampithoe dalli Shoemaker, 1938														
Ampithoe valida Smith, 1873	67	58			12	64	58	17	9	2	1	47		1
Aoroides columbiae Walker, 1898												233	181	57
Caprella alaskana Mayer, 1903						1		240			51	542	5	35
Caprella drepanochir Mayer, 1890														
Caprella irregularis Mayer, 1890														
Caprella laeviuscula Mayer, 1903						3	5	4	8			12	17	50
Eogammarus confervicolus (Stimpson, 1856)									1					
Eogammarus oclairi Bousfield, 1979	20	8										1		1
Exampithoe sp.												13		
Gammaridea indet.					2	122					1			

Appendix (continued)

Taxon	Vancouver					Nanaimo						Esquimalt		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Hyale frequens (Stout, 1913)														
Hyale pugettensis (Dana, 1853)												67		
Ischyrocerus anguipes Kroyer, 1838														
Jassa marmorata Holmes, 1903														
Jassa slatteryi Conlan, 1990						241	824		1		1			
Jassa staudei Conlan, 1990							1	453	41	11	30	839	5	63
Metacaprella anomala (Mayer, 1903)								14				1		
Metacaprella kennerlyi (Stimpson, 1864)														1
Microjassa cf. litotes Barnard, 1954												7	14	54
Micropleustes nautilus (Barnard, 1969)					2		2							
Micropleustes sp.					2									
Monocorophium carlottensis Bousfield and Hoover, 1997	66	8			7	85	639	240	30	2	1		15	1
Pontogeneia cf. rostrata Gurjanova, 1938														
Protohyale sp.					17	10								
Ptilohyale plumulosa (Stimpson, 1857)	27	13		5								1		
Stenothoidae sp.														
Trachypleustes trevori Bousfield and Hendrycks, 1995	44	14		11	24	242	2	16	2	1	2	171	61	59
Arthropoda: Crustacea: Decapoda														
Cancer gracilis Dana, 1852					1									
Cancer magister Dana, 1852	12	1												
Cancer oregonensis (Dana, 1852)												2		
Cancer productus Randall, 1840						1								
Hemigrapsus oregonensis (Dana, 1851)					3	6	8	2	1	3	29			
Heptacarpus brevirostris (Dana, 1852)												1		
Hippolyte clarki Chace, 1951							13	3	1	6				
Pugettia dalli Rathbun, 1893														
Pugettia richii Dana, 1851												1		
Arthropoda: Pycnogonida														
Anoplodactylus viridintestinalis Cole, 1904					1							15	1	71

Appendix (continued)

Taxon	Vancouver					Nanaimo						Esquimalt		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Arthropoda: Arachnida														
Acarid					58	3					1		3	1
Arthropoda: Insecta														
Chironomidae spp.	24	48	1	31	186	13	3	1			2	2	1	
Bryozoa														
Bowenbankia gracilis Leidy, 1855												x	x	
*Celleporella hyalina (*Linnaeus, 1767)													x	
Conopeum seurati (Canu, 1928)														
Dendrobeania lichenoides (Robertson, 1900)													x	x
Membranipora serrilamella Osburn, 1950				x	x									
Schizoporella pseudoerrata Soule, Soule & Chaney, 1995												x		x
Schizoporella unicornis (Johnston, 1874)													x	x
Tegella armifera (Hincks, 1880)												x		
Echinodermata: Holothurioidea														
Eupentacta quinquesemita (Selenka, 1867)														13
Echinodermata: Asteroidea														
Sea star						1								
Tunicata: Ascidiacea														
Aplidium californicum (Ritter and Forsyth, 1917)												x	x	x
Ascidia columbiana (Huntsman, 1912)													x	x
Botrylloides violaceus Oka, 1927												x		x
Corella willmeriana Herdman, 1898														
Distaplia occidentalis Bancroft, 1899												x		
Perphora annectens														x
Ritterella rubra Abbott & Trason, 1968													x	
Styela truncate Ritter, 1901														1

Appendix (continued)

Taxon	Vancouver					Nanaimo						Esquimalt		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Vertebrata: Osteichthyes														
Liparidae sp.														
Others														
Ctenophora								1	1	1				

Appendix (continued)

Taxon	Prince Rupert								Port Alberni		
	15	16	17	18	19	20	21	22	23	24	25
Porifera											
Halichondria bowerbanki Burton, 1930											
Cnidaria											
Coral											
Actinia	1			2						1	
Cnidaria: Hydrozoa											
Bougainvillia sp.											
Clava sp.		x			x						
Cordylophora caspia (Pallas, 1771)									x	x	x
Eutonina sp.											
Garveia annulata Nutting, 1901			x								
Obelia cf. dichotoma (Linnaeus, 1758)	x	x	x	x	x		x				
Sarsia tubulosa (Sars, 1835)		x	x		x						
Platyhelminthes											
Platyhelminth	1			1	2						2
Nemertea											
Amphiporus sp.				2		1					
Emplectonema gracile (Johnston, 1837)	3					1		1			
Paranemertes peregrina Coe, 1901				1							
Sipunculida											
Phascolosoma agassizii Keferstein 1866		1									
Annelida: Polychaeta											
Amblyosyllis cf. speciosa Izuka, 1912											
Amphiglena cf. mediterranea (Leydig, 1851)											
Armandia brevis (Moore, 1906)	105										
Arcteobia sp.							1				
Autolytus cf. magnus Berkeley, 1923											
Boccadia columbiana Berkeley, 1927				2	10						

Appendix (continued)

Taxon	Prince Rupert								Port Alberni		
	15	16	17	18	19	20	21	22	23	24	25
Brania brevipharyngea Banse, 1972											
Capitella capitata (Fabricius, 1780)	10										
Chone minuta Hartman, 1944											
Clavadoce sp.											
Crucigera zygophora (Johnson, 1901)				1							
Eteone longa (Fabricius, 1780)											
Eudistylia vancouveri (Kinberg, 1867)		5		18	4		1				
Eulalia aviculiseta Hartman, 1936				3	2	1					
Eusyllis blomstrandi Malmgren, 1867				16	3		4				
Eusyllis japonica Imajima and Hartman, 1964							1				
Exogone (Exogone) dwisula Kudenov and Harris, 1905		2									
Halosydna brevisetosa Kinberg, 1855	2			1							
Harmothoe imbricata (Linnaeus, 1767)	2			1							
Maldanidae											
Micropodarke dubia (Hessle, 1925)	8										
Minuspio cirrifera (Wiren, 1883)											
Nereis vexillosa Grube, 1851	2					1		1			
Nereis pelagica Linnaeus, 1758	1	4		6			1				
Nereis cf. zonata Malmgren, 1867											
Paleanotus bellis (Johnson, 1897)		1					1				
Paradexiospira cf. vitrea (Fabricius, 1780)				54	12						
Perinereis sp.											
Pholoe minuta (Fabricius, 1780)											
Pionosyllis sp.		1									
Platynereis bicanaliculata (Baird, 1863)	11			10	3	12	14				
Podarke pugettensis Johnson, 1901											
Polydora cornuta Bosc, 1802											
Polydora limicola Annenkova, 1934	1	3			23						
Polydora pigidialis Blake and Woodwick, 1972											

Appendix (continued)

Taxon	Prince Rupert								Port Alberni		
	15	16	17	18	19	20	21	22	23	24	25
Polydora websteri Hartman, 1943											
Proceraea cornuta (Agassiz, 1862)	6	6	12	14	3		8				
Questidae sp.				1							
Sabellidae sp.				1							
Schizobranchia insignis Bush, 1904	9	29		24	18		4				
Serpula vermicularis Linnaeus, 1767					1						
Sphaerosyllis californiensis Hartman, 1966		2			1		1				
Spionidae sp.							1				
Spirorbella sp.					1						
Thelepus sp.											
Typosyllis adamanteus (Treadwell, 1914)											
Typosyllis alternata (Moore, 1908)				1							
Typosyllis armillaris (Müller, 1776)		5									
Typosyllis cf. pulchra (Berkeley and Berkeley, 1938)	2	11		25	3						
Typosyllis cf. hyalina (Grube, 1863)	1	4									
Annelida: Oligochaeta											
Enchytraeidae sp.									46		
Nais elinguis Müller, 1773									35	193	237
Tubificoides sp.							1				
Mollusca: Polyplacophora											
Katharina tunicata (Wood, 1815)					3						
Mopalia sp.1		3		1							
Mopalia sp.2				3							
Mopalia ciliata (Sowerby II, 1840)											
Mopalia cirrata Berry, 1919											
Mollusca: Gastropoda											
Dentronotus sp.			9			1					
Doto columbiana O'Donoghue, 1921				13							

Appendix (continued)

Taxon	Prince Rupert								Port Alberni		
	15	16	17	18	19	20	21	22	23	24	25
Doto sp.							1				
Flabellina sp.				1			2				
Gastropod sp.1											
Haminoea cf. vesicula (Gould, 1855)											
Lacuna sp.											
Lottia spp.		24	3	41	24	3	1	2			
Littorina sp.				1							
Nudibranch spp.									19	4	2
Polinices sp.		1	6	10			2	10			
Mollusca: Bivalvia											
Entodesma sp.				3							
Lyonsia sp.		14		25	12						
Modiolus sp.									1		8
Mytilus trossulus complex Gould, 1850		4	3	3				2			
Arthropoda: Crustacea: Ostracoda											
Cypridinidae spp.											
Arthropoda: Crustacea: Cirripedia											
Balanus crenatus Bruguiere, 1789	36				1		4				
Balanus glandula Darwin, 1854		6	10	1	75	137	1	284			
Balanus improvisus Darwin, 1854									667	74	201
Balanus nubilus Darwin, 1854											
Chthamalus dalli Pilsbry, 1916		209		4	115						
Semibalanus cariosus (Pallas, 1788)	3	13		5	39						
Solidobalanus hesperius (Pilsbry, 1916)				16							
Arthropoda: Crustacea: Tanaidacea											
Anatanais pseudonormani Sieg and Winn, 1981											
Leptochelia dubia (Krøyer, 1842)											
Zeuxo normani (Richardson, 1905)									450	221	578

Appendix (continued)

Taxon	Prince Rupert								Port Alberni		
	15	16	17	18	19	20	21	22	23	24	25
Arthropoda: Crustacea: Cumacea											
Leuconidae spp.											
Arthropoda: Crustacea: Isopoda											
Asellota indet. (head only)											
Elthusa californica (Schioedte and Meinert, 1884)											
Epicaridea indet.											
Gnorimosphaeroma oregonensis (Dana, 1853)								2	4		3
Ianiropsis analoga Menzies, 1952				93							
Ianiropsis tridens Menzies, 1952					2						
Idotea schmittii Menzies, 1950											
Idotea wosnesenskii (Brandt, 1851)								1			
Idotea sp.							1				
Limnoria sp.	3										
Janiralata occidentalis (Walker, 1898)											
Munna stephenseni Gurjanova, 1933		1		83	8		12	8			
Arthropoda: Crustacea: Amphipoda											
Americorophium brevis (Shoemaker, 1949)							4	3			
Americorophium spinicorne (Stimpson, 1857)									22	21	26
Ampithoe dalli Shoemaker, 1938	1			52	1	344	6	44			
Ampithoe valida Smith, 1873			3				2				
Aoroides columbiae Walker, 1898		16		354	14		1	3			
Caprella alaskana Mayer, 1903											
Caprella drepanochir Mayer, 1890			7								
Caprella irregularis Mayer, 1890				84							
Caprella laeviuscula Mayer, 1903							31	10			
Eogammarus confervicolus (Stimpson, 1856)									2		12
Eogammarus oclairi Bousfield, 1979											
Exampithoe sp.											
Gammaridea indet.											

Appendix (continued)

Taxon	Prince Rupert								Port Alberni		
	15	16	17	18	19	20	21	22	23	24	25
Hyale frequens (Stout, 1913)						1		1			
Hyale pugettensis (Dana, 1853)											
Ischyrocerus anguipes Kroyer, 1838					5		7	2			
Jassa marmorata Holmes, 1903										1	
Jassa slatteryi Conlan, 1990											
Jassa staudei Conlan, 1990	1			581		657		1			
Metacaprella anomala (Mayer, 1903)								1			
Metacaprella kennerlyi (Stimpson, 1864)			1			1	1				
Microjassa cf. litotes Barnard, 1954				1			3	1			
Micropleustes nautilus (Barnard, 1969)											
Micropleustes sp.											
Monocorophium carlottensis Bousfield and Hoover, 1997	2			6			14				
Pontogeneia cf. rostrata Gurjanova, 1938							1				
Protohyale sp.											
Ptilohyale plumulosa (Stimpson, 1857)											
Stenothoidae sp.				79	62	1	4				
Trachypleustes trevori Bousfield and Hendrycks, 1995	22	5	11	267	45		24	45			
Arthropoda: Crustacea: Decapoda											
Cancer gracilis Dana, 1852											
Cancer magister Dana, 1852											
Cancer oregonensis (Dana, 1852)	2	1									
Cancer productus Randall, 1840											
Hemigrapsus oregonensis (Dana, 1851)							1				
Heptacarpus brevirostris (Dana, 1852)		2			5						
Hippolyte clarki Chace, 1951											
Pugettia dalli Rathbun, 1893		3									
Pugettia richii Dana, 1851											
Arthropoda: Pycnogonida											
Anoplodactylus viridintestinalis Cole, 1904		2		12			1				

Appendix (continued)

Taxon	Prince Rupert								Port Alberni		
	15	16	17	18	19	20	21	22	23	24	25
Arthropoda: Arachnida											
Acarid		1		1	1						
Arthropoda: Insecta											
Chironomidae spp.	4		23	14	5	59	5	51	22	5	54
Bryozoa											
Bowenbankia gracilis Leidy, 1855							x				
*Celleporella hyalina (*Linnaeus, 1767)				x	x		x				
Conopeum seurati (Canu, 1928)									x	x	x
Dendrobeania lichenoides (Robertson, 1900)		x									
Membranipora serrilamella Osburn, 1950							x				
Schizoporella pseudoerrata Soule, Soule & Chaney, 1995											
Schizoporella unicornis (Johnston, 1874)											
Tegella armifera (Hincks, 1880)											
Echinodermata: Holothurioidea											
Eupentacta quinquesemita (Selenka, 1867)											
Echinodermata: Asteroidea											
Sea star											
Tunicata: Ascidiacea											
Aplidium californicum (Ritter and Forsyth, 1917)											
Ascidia columbiana (Huntsman, 1912)											
Botrylloides violaceus Oka, 1927											
Corella willmeriana Herdman, 1898							1				
Distaplia occidentalis Bancroft, 1899											
Perphora annectens											
Ritterella rubra Abbott & Trason, 1968											
Styela truncate Ritter, 1901											

Appendix (continued)

Taxon	Prince Rupert								Port Alberni		
	15	16	17	18	19	20	21	22	23	24	25
Vertebrata: Osteichthyes											
Liparidae sp.	1										
Others											
Ctenophora											